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EFFECT OF SUPPLEMENTATION OF NON STARCH POLYSACCHARIDE HYDROLYZING ENZYMES ON NUTRIENT UTILIZATION AND ECONOMICS OF BROILER PRODUCTION

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ABSTRACT

Two hundred and fifty one-day old Ven-Cobb straight run commercial broiler chicks were supplemented with the NSP hydrolyzing enzymes at 1X (HC) concentration viz. (xylanase, ß-D-glucanase, cellulase, mannanase and pectinase @ 2400, 4800, 1800, 4800, and 2400 IU/kg respectively and the same enzyme combination was supplemented @ 4800,9600,3600,9600 and 4800 IU/kg respectively as 2X (HC) to the corn + soybean meal based standard diet. Similarly the corn + soybean meal diet was supplemented with NSP hydrolyzing enzymes at 1X (LC) viz. (xylanase, ß-D-glucanase, cellulase, mannanase and pectinase @ 400, 240, 200, 200, and 400 IU/kg respectively and the same NSP hydrolyzing enzyme combination was supplemented @ 800,480,400,400 and 800 IU/Kg respectively as 2X (LC). The birds were weighed, wing banded and randomly distributed in to five experimental groups, with ten replicates and five birds in each replicate to assess the effect of the NSPHE combination on nutrient retentions and cost economics. The NSP hydrolyzing enzymes at 1X (HC) level viz. (xylanase, ß-D-glucanase, cellulase, mannanase and pectinase @ 2400, 4800, 1800, 4800, and 2400 IU/kg respectively has influenced the protein and energy utilization @1X (HC) and also evolved as an economical combination for the commercial broiler birds reared on the standard corn soybean meal based diet. However the NSP hydrolyzing enzymes did not influenced the overall nutrient retention and were not found to be economical when supplemented @ 1X (LC) , 2X (LC) and 2X (HC) to the corn soybean meal based diets.

KEYWORDS: Non Starch Polysaccharide Hydrolyzing Enzymes, Lower Concentration, Higher Concentration

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INTRODUCTION

Cereals and vegetable protein sources form the major ingredients in poultry rations. These ingredients contain between 10-75% of non-starch polysaccharides (NSP) (Chot, 2011). The NSP in cereals form a part of the cell wall structure and in vegetable proteins, especially legumes, play a role as an energy storage material. Chicken having a simple stomach, cannot digest complex nutrients like non-starch polysaccharides (NSP). Supplementation of chicken diet with fiber degrading enzymes is known to enhance utilization of the complex carbohydrate moiety (Choct, 2006). With the continuous increase in world's population and the decline in its food reserve, a more efficient conversion of by-products, including those rich in NSP, into high quality food is a top priority area of research today.

Soybean meal (SBM) is being used as sole protein source in recent years which contains about 20% NSP (Malathi and Devegowda, 2001). Similarly, other major ingredients used in broiler and layer diets *i.e.*, maize and rice bran contains 9 and 25% NSP, respectively (Malathi and Devagowda, 2001) half of which is cellulose (Saunders, 1986). The NSPs are insoluble (cellulose) and soluble (β-glucose, arabinoxylan, arabinogalactose,

xyloglucon etc). The soluble NSPs have the property to immobilize water in its matrix by forming loose gel network which is responsible for increased viscosity, there by depressing the digestibility of fats, proteins and starch. These NSPs impair activity of endogenous enzymes by reducing the contact intensity between nutrients and enzymes, which results in sticky and moist droppings.

Use of feed enzymes to improve the nutritive value of poultry diets has become common practice in many countries due to use of feed ingredients containing higher proportion of NSP. Hong *et al.* (2002) found that the use of an enzyme cocktail (Xylanase, amylase and protease) improved the digestibility of corn-soybean based diets in ducks. Using enzymes in poultry diets not only enhance bird performance and feed conversion, but also reduce environmental problems due to reduced concentration of nutrients in excreta. Similarly the other possible benefits are increased accuracy and flexibility in least-cost feed formulation and improved well being of the birds.

MATERIALS AND METHODS

The present experiment was conducted on two hundred and fifty (250) one day old straight run Ven-Cobb commercial broiler chicks supplemented with the NSP hydrolyzing enzymes viz xylanase, ß-d-glucanase, cellulase, mannase and pectinase at higher (HC) as well as lowers concentrations (LC) on corn- soybean meal diet (Table 1) with *iso caloric* and *iso nitrogenous* levels. These pure enzymes were procured from Advanced Bio- Agrotech Limited, Pune, India. The activity of xylanase, ß-d-glucanase, cellulase, mannase and pectinase was 160000, 200000, 1000000, 200000 IU/g, and 150000 respectively,. The birds were weighed, wing banded and randomly distributed in to five experimental groups, with ten replicates and five birds in each replicate (Table 2). All the birds were reared under standard managemental conditions. The details of the NSPHE and ingredient composition for the experiment I have been given in (Table 3).The data were subjected to appropriate statistical analysis using Statistical Package for Social Sciences (SPSS) 15th version and comparison of means was tested using Duncan's multiple range tests (Duncan's, 1955).

Table 1: Details of Experimental Diets Broiler Experiment

Diet	Dietary Group	Metabolizable Energy (kcal/kg diet)		
		Pre-starter	Starter	Finisher
I	Control corn - soybean meal Diet without NSPHE	2950	3050	3150
II	Control + 1X (HC) NSPHE	2950	3050	3150
III	Control + 2X (HC) NSPHE	2950	3050	3150
IV	Control + 1X (LC) NSPHE	2950	3050	3150
V	Control + 2X (LC) NSPHE	2950	3050	3150

Table 2: Details of the NSP Hydrolyzing Enzyme Concentrations Selected for Broiler Experiment

Higher Combinations (HC) - for Diets with Corn - Soybean Meal					
Percentage of Enzyme	**Xylanase (IU/kg)**	**β-D-glucanase (IU/kg)**	**Cellulase (IU/kg)**	**Mannanase (IU/kg)**	**Pectinase (IU/kg)**
60% **(1X)**	2400	4800	1800	4800	2400
120% **(2X)**	4800	9600	3600	9600	4800
Lower Combinations (LC) – for Diets with Corn Soybean Meal					
200% **(1X)**	400	240	200	200	400
400% **(2X)**	800	480	400	400	800

Table 3: Ingredient Composition of Experimental Diets of Broiler Experiment

Ingredient (g/kg)	Prestarter	Starter	Finisher
Maize	524.48	571.04	623.04
Soybean meal	402.32	372.05	310.51
Oil (veg)	31.32	17.24	28.96
Salt	3.8	3.8	3.8
DL-Methionine	2.040	2.21	1.89
Di-Calcium Phosphate	19.97	17.24	16.17
Shell grit	10.60	11.45	10.89
Trace mineral mixture[1]	1.00	1.00	1.00
AB2D3K[2]	0.150	0.150	0.150
B-Complex[3]	0.100	0.100	0.100
Choline Chloride, 50%	0.50	0.50	0.50
Toxin Binder	2.0	2.0	2.0
Antibiotic	0.50	0.50	0.50
L-lysine HCL	0.720	0.410	0.00
Coccidiostat	0.50	0.50	0.50
Tylan	0.50	0.50	0.50
Total	**1000**	**1000**	**1000**
Nutrient Composition (calculated)			
ME(kcal/kg)	2950.00	3050.00	3150.00
Protein (%)	23.00	21.00	19.50
Calcium (%)	0.90	0.85	0.80
Available phosphorus (%)	0.45	0.40	0.38
Lysine (%)	1.36	1.20	1.07
Methionine (%)	0.56	0.55	0.50

[1]Trace mineral provided per kg diet: manganese, 120mg; Zinc, 80mg; Iron, 25mg; Copper, 10mg; Iodine, 1mg; and Selenium, 0.1mg. [2] Vitamin premix provided per kg diet: Vitamin A, 20000IU; Vitamin D_3, 3000IU; Vitamin E, 10mg; Vitamin K,2mg; [3] Riboflavin, 25mg; Vitamin B_1, 1mg; Vitamin B_6, 2mg: vitamin B_{12}, 40mcg and Niacin, 15mg

RESULTS AND DISCUSSIONS

There were significant ($P<0.05$) variation in protein utilization between diets. protein utilization was influenced by NSP hydrolyzing enzyme supplementation @1X (HC) which resulted in maximum protein utilization (72.27%) followed by T_1, T_3,T_4 and T_5 (69.26, 67.30, 61.12 and 60.32 %) respectively. Protein utilization in broilers had shown significant differences ($P<0.05$) in the NSPHE supplemented diet. These findings are in agreement with Bhatt *et al.* (1991) who reported supplementation of broiler diets with Novozyme sp-243 (cellulase and hemicellulase) at 20, 25, 30 g/100 kg improved ($P<0.05$) CP digestibility.

The improvement in digestibility could be due to release of proteins and storage polysaccharides from the cell walls. Swift *et al.* (1996) revealed enzyme treatment significantly improved nitrogen and energy digestibility in broilers. Bedford and Morgan, (1996) also reported that the xylanase supplementation to broiler diets improved the availability of protein. Marsman *et al.* (1997) reported that supplementation of Neutrase (commercial enzyme containing protease) and Energex to conventional broiler diets improved ileal digestibility of CP. Zanella *et al.* (1999) investigated the effect of a commercial enzyme cocktail containing xylanase, protease and amylase on performance of broilers fed a corn-soybean meal based diet. Enzyme supplementation improved ileal digestibility of crude protein. Saleh *et al.* (2005) observed that crude proteins were significantly improved in pure enzyme mix group. Khan *et al.* (2006) reported that the apparent digestibilities of CP and energy were increased ($P<0.05$) with supplementation of enzymes. Manwar and Mandal (2009)

reported significantly (P<0.01) improved digestibility of nitrogen retentions (P<0.05). Song *et al.* (2010) reported higher protein availability with supplementation to 0.01% enzyme combination. Narasimha *et.al.* (2013[a]) reported that retention of CP and GE was significantly (P<0.05) improved with addition of NSP enzymes Table 4.

There were significant (P<0.05) differences in energy utilization between the diets. The supplementation of NSPHE at 1X (HC) showed significantly (P<0.05) higher energy utilization (80.33) compared to the control diet and NSPHE supplemented groups @ 2X (HC), 1X and 2X (LC) (78.04, 75.52, 74.59 and 73.14 %) respectively. Energy utilization in broilers had shown significant differences (P<0.05) in the NSPHE supplemented diet @ 1X (HC).These findings are in accordance with Swift *et al.* (1996) and Gracia *et al.* (1997). Ravindran *et al*. (1999) reported that the supplementation of xylanase and phytase had synergistic effects with respect to increasing AME. Chesson, (2001) reported that addition of NSPHE to cereal based diets in poultry restored ME content which was not available due to NSPs. Khan *et al*. (2006) and Slominski *et al.* (2006) reported efficiency of energy utilization was better in birds fed on enzyme supplemented diets. Coweison and Ravindran (2008[a]) observed improved AME. Manwar and Mandal (2009), Mushtaq *et al.* (2009) also reported enzyme supplementation improved the apparent ME. Narasimha *et.al.* (2013[a]) reported retention of GE was significantly (P<0.05) improved with addition of NSP enzymes Table 4.

Table 4: Effect of Supplementation of Non Starch Polysaccharide Hydrolyzing Enzymes to Corn Soybean Meal Diets on Protein and Energy Utilization (%) of Broilers

Treatments	Enzymes	Protein %	Energy %
T_1	0	69.26^b	78.04^b
T_2	1X HC	72.27^a	80.33^a
T_3	2X HC	67.30^c	75.52^c
T_4	1X LC	60.32^d	74.59^c
T_5	2X LC	61.12^d	73.14^d
SEM		0.97	0.54
P value		0.000	0.000

Values bearing different superscripts within a column are significantly (P<0.05) different

The cost per kg live weight gain of the broilers was calculated by considering the feed cost, miscellaneous cost and cost of NSPHE at various phases (pre starter, starter and finisher) and is given in Table 5.

The cost of production per kg live weight gain was lowest in treatment T_2 (Rs.) 63.89 diet supplemented with NSPHE @ 1X (HC) and the control diet T_1(Rs) 64.84.However the cost of production per kg live weight gain was highest in the 2X (HC) NSPHE supplemented diet (Rs.) 67.01.The cost of production per kg live weight gain was comparatively less in T_4 and T_5 treatments (Rs.) 66.92 and 66.93 respectively.

The NSP enzyme supplemented diet @1X (HC) has evolved as an economical combination for the broilers reared on corn- soy standard diet Table 5.However the supplementations of the NSP hydrolyzing enzymes @ 2X HC, 1X and 2X (LC) was not found to be economical compared with the control. The present findings are in accordance with Augelovicova and Michalik, (1997), Morkanas *et al.* (1993), Edwin *et al.* (2004) and Khan *et al.* (2006) who reported that feed cost was reduced by enzyme supplementation to the diet.

Enzymes at higher doses failed to exert as an economical tool. The cost of enzyme will be an additional expenditure apart from the feed cost. Hence the NSPHE @ 2X (HC) has not yielded any beneficial effects. These findings

are supported by Altaf-ur-Rahman *et.al* (2007) concluded that addition of Driselase1 up to 4g/kg ration for commercial broilers was found to be uneconomical.

Table 5: Cost /kg Live Weight Gain of Broiler Fed on Corn Soybean Meal Diets Supplemented with Non Starch Polysaccharide Hydrolyzing Enzymes at 42nd Day of Age - Experiment I

Particulars	TREATMENTS				
	T_1	T_2	T_3	T_4	T_5
Chick cost (Rs.)	23	23	23	23	23
Pre Starter feed intake/bird (g)	462.4	455	452.4	473.4	466.6
Starter feed intake/bird (g)	1448.8	1414.4	1249.1	1352	1256.1
Finisher feed intake/bird (g)	2322.2	2408.2	2238	2277.4	2267
Pre Starter feed cost (Rs.)/kg	27.65	27.65	27.65	27.65	27.65
Starter feed cost (Rs.)/kg	26.51	26.51	26.51	26.51	26.51
Finisher feed cost (Rs.)/kg	32.57	32.57	32.57	32.57	32.57
Total Pre Starter feed cost /bird (Rs.)	12.79	12.58	12.51	13.09	12.90
Total Starter feed cost/bird (Rs.)	38.41	37.50	33.11	35.84	33.30
Total finisher feed cost /bird (Rs.)	75.63	78.44	72.89	74.17	73.84
Total feed cost /bird (Rs.)	126.83	128.51	118.51	123.11	120.04
Miscellaneous cost (Rs.)/bird	4.00	4.00	4.00	4.00	4.00
Cost of NSP,hydrolyzing enzymes (Rs.)/bird	0.00	0.80	1.60	0.20	0.40
Total input cost (Rs.)/Bird	**153.83**	**156.31**	**147.11**	**150.30**	**147.44**
Total input cost (Rs.)/kg live BWG	**64.84**	**63.89**	**67.01**	**66.92**	**66.93**
Live body weight gain (g) at 42 d	**2372.4**	**2446.6**	**2195.4**	**2246**	**2203**
Sale rate/kg live weight	**68.00**	**68.00**	**68.00**	**68.00**	**68.00**
Difference in total input cost over control	**+3.16**	**+ 0.95**	**-2.17**	**-2.08**	**-2.09**

CONCLUSIONS

The NSPHE combinations @ 1X (HC) viz. (xylanase, ß-D-glucanase, cellulase, mannanase and pectinase @ 2400, 4800, 1800, 4800, and 2400 IU/kg respectively have influenced the protein and energy utilization in broilers. Similarly the NSPHE combination @ 1X (HC) was found to be economical in the standard corn-soy control diet. However the NSPHE combination @ 1X, 2X (LC) and 2X (HC) had failed to exert any significant effect in energy and protein utilization in broiler diet. The incorporation of NSP hydrolyzing enzymes at higher levels 2X (HC) was not found to be economical. It can also be concluded that the NSPHE are less effective at 1X and 2X (LC) in relation to protein and energy utilization. NSPHE at lower doses did not yielded any significant effect pertaining to the economics of broiler production.

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